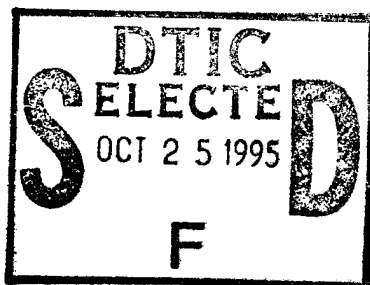




US Army Corps  
of Engineers

Construction Engineering  
Research Laboratories



USACERL ADP Report 95/28  
August 1995

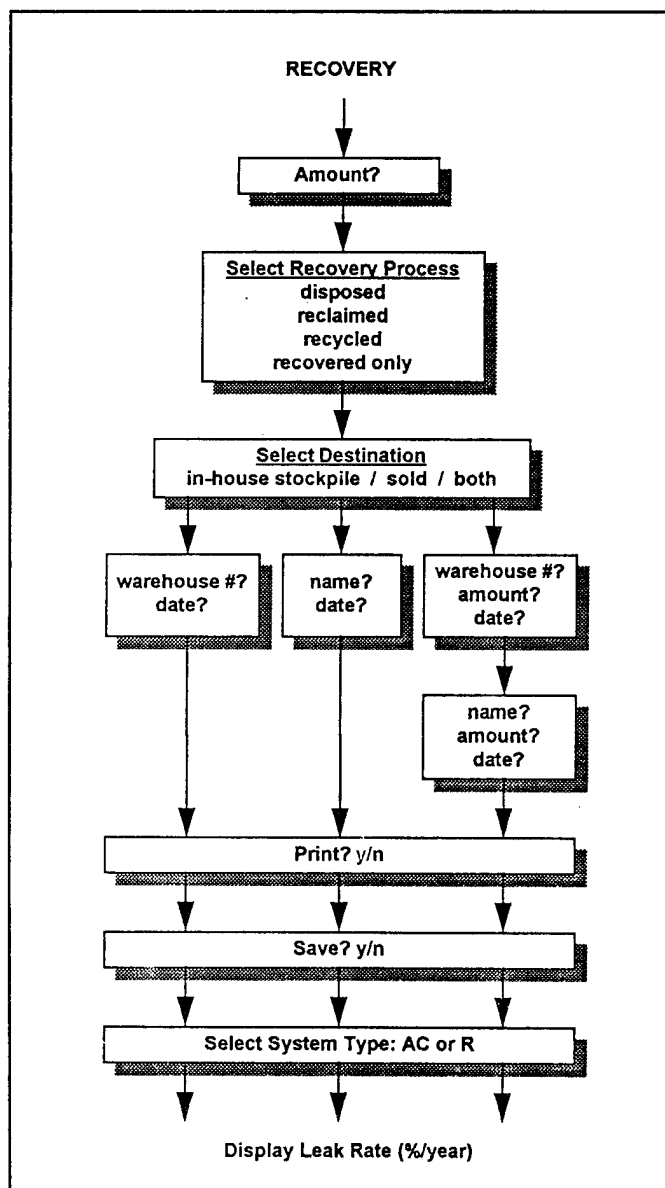
# The Computerized Refrigerant Management System (RMS)

## User Guide and Technical Reference

by  
Chang Sohn  
Kwan Yi  
Nancy Herring  
Brian E. Boughton

Since the signing of the Montreal Protocol on Chlorofluorocarbons (CFCs), several policies and regulations have come into effect to reduce the impact ozone-depleting substances have on the environment. Part of the policy established by Department of Defense (DOD), for example, seeks to decrease dependence on CFCs and halons by developing a tracking system to document the DOD's annual requirements for these substances. As yet, no refrigerant inventory data base exists, nor is there a system to record refrigerant recoveries from air-conditioning and refrigerant (AC/R) equipment or their subsequent storage in refrigerant stockpiles.

In this study, the U.S. Army Construction Engineering Research Laboratories (USACERL) developed and is field-testing the *Refrigerant Management System (RMS)*, which tracks refrigerant additions and recoveries in AC/R systems at Army installations. RMS also provides an inventory data base for refrigerant inventory control, reporting, and management as dictated by applicable laws and regulations. RMS consists of two program modules to perform the necessary data collection and report generation, and will run on any 80286-based (or higher) IBM-compatible personal computer.



19951024 111

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

***DESTROY THIS REPORT WHEN IT IS NO LONGER NEEDED***

***DO NOT RETURN IT TO THE ORIGINATOR***

## USER EVALUATION OF REPORT

REFERENCE: USACERL ADP Report 95/28, *The Computerized Refrigerant Management System (RMS)*

Please take a few minutes to answer the questions below, tear out this sheet, and return it to USACERL. As user of this report, your customer comments will provide USACERL with information essential for improving future reports.

1. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which report will be used.)

---

---

---

2. How, specifically, is the report being used? (Information source, design data or procedure, management procedure, source of ideas, etc.)

---

---

3. Has the information in this report led to any quantitative savings as far as manhours/contract dollars saved, operating costs avoided, efficiencies achieved, etc.? If so, please elaborate.

---

---

4. What is your evaluation of this report in the following areas?

a. Presentation: \_\_\_\_\_

b. Completeness: \_\_\_\_\_

c. Easy to Understand: \_\_\_\_\_

d. Easy to Implement: \_\_\_\_\_

e. Adequate Reference Material: \_\_\_\_\_

f. Relates to Area of Interest: \_\_\_\_\_

g. Did the report meet your expectations? \_\_\_\_\_

h. Does the report raise unanswered questions? \_\_\_\_\_

i. General Comments. (Indicate what you think should be changed to make this report and future reports of this type more responsive to your needs, more usable, improve readability, etc.)

---

---

---

---

---

---

5. If you would like to be contacted by the personnel who prepared this report to raise specific questions or discuss the topic, please fill in the following information.

Name: \_\_\_\_\_

Telephone Number: \_\_\_\_\_

Organization Address: \_\_\_\_\_

---

---

6. Please mail the completed form to:

Department of the Army  
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES  
ATTN: CECER-TR-I  
P.O. Box 9005  
Champaign, IL 61826-9005

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE August 1995		3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE The Computerized Refrigerant Management System (RMS): User Guide and Technical Reference				5. FUNDING NUMBERS 4A162784 AT45 FE-XM4	
6. AUTHOR(S) Chang Sohn, Kwan Yi, Nancy Herring, and Brian Boughton					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Construction Engineering Research Laboratories (USACERL) P.O. Box 9005 Champaign, IL 61826-9005				8. PERFORMING ORGANIZATION REPORT NUMBER  ADP 95/28	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Center for Public Works (USACPW) ATTN: CECPW-EM 7701 Telegraph Road Alexandria, VA 22312-3862				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.					
12a. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) <p>Since the signing of the Montreal Protocol on Chlorofluorocarbons (CFCs), several policies and regulations have come into effect to reduce the impact ozone-depleting substances have on the environment. Part of the policy established by Department of Defense (DOD), for example, seeks to decrease dependence on CFCs and halons by developing a tracking system to document the DOD's annual requirements for these substances. As yet, no refrigerant inventory data base exists, nor is there a system to record refrigerant recoveries from air-conditioning and refrigerant (AC/R) equipment or their subsequent storage in refrigerant stockpiles.</p> <p>In this study, the U.S. Army Construction Engineering Research Laboratories (USACERL) developed and is field-testing the Refrigerant Management System (RMS), which tracks refrigerant additions and recoveries in AC/R systems at Army installations. RMS also provides an inventory data base for refrigerant inventory control, reporting, and management as dictated by applicable laws and regulations. RMS consists of two program modules to perform the necessary data collection and report generation, and will run on any 80286-based (or higher) IBM-compatible personal computer.</p>					
14. SUBJECT TERMS chlorofluorocarbons refrigerants Clean Air Act				15. NUMBER OF PAGES 42	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified		18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified		19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	
				20. LIMITATION OF ABSTRACT SAR	

## Foreword

This study was conducted for the U.S. Army Center for Public Works (USACPW) under Project 4A162784AT45, "Energy and Energy Conservation"; Work Unit FE-XM4, "CFC Alternative Refrigerant Technologies." The technical monitor was Dennis Vevang, CECPW-EM.

The work was performed by the Utilities Division (UL-U) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). Martin J. Savoie is Chief, CECER-UL-U, John T. Bandy is Operations Chief, and Gary W. Schanche is Chief, CECER-UL. The USACERL technical editor was William J. Wolfe, Technical Resources Center.

COL James T. Scott is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

Accession For		
NTIS	CRA&I	<input checked="" type="checkbox"/>
DTIC	TAB	<input type="checkbox"/>
Unannounced		<input type="checkbox"/>
Justification _____		
By _____		
Distribution /		
Availability Codes		
Dist	Avail and/or Special	
A-1		

# Contents

<b>SF 298</b>	<b>1</b>
<b>Foreword</b>	<b>2</b>
<b>List of Figures</b>	<b>4</b>
<b>1 Introduction</b>	<b>7</b>
Background	7
Objectives	8
Approach	8
Scope	9
Mode of Technology Transfer	9
<b>2 RMS Level 1 Program</b>	<b>10</b>
Program Overview	10
Program Requirement	10
Input Management	11
Running the Program	12
Output Management	22
Discussion of Output	23
<b>3 RMS Level 2 Program</b>	<b>25</b>
Program Overview	25
Program Requirement	26
Running the Program	26
<b>4 Sample Program Run</b>	<b>28</b>
Sample Run of Level 1 Program	28
Discussion of Level 1 Sample Output	33
<b>5 Summary</b>	<b>34</b>
<b>References</b>	<b>35</b>
<b>Appendix A: Definitions of Refrigerant Conditions</b>	<b>36</b>
<b>Appendix B: Program Flow Charts</b>	<b>37</b>
<b>Distribution</b>	

## List of Figures

### Figures

1	The RMS Level 1 Main Menu . . . . .	12
2	Flow chart for ADD A NEW CHILLER menu option . . . . .	13
3	Flow chart for RETIRE A CHILLER menu option . . . . .	14
4	Flow chart for INPUT A TRANSACTION menu option . . . . .	15
5	Flow chart for Addition Transactions . . . . .	16
6	Flow chart for Recovery Transactions . . . . .	18
7	Flow chart for DELETE A TRANSACTION menu option . . . . .	19
8	Flow chart for RETRIEVE A TRANSACTION menu option . . . . .	19
9	Flow chart for RETRIEVE ALL TRANSACTIONS menu option . . . . .	20
10	Flow chart for EDIT A TRANSACTION menu option . . . . .	21
11	Flow chart for INPUT INITIAL INVENTORY menu option . . . . .	22
12	Chiller Description output screen . . . . .	23
13	Refrigerant Recovery output screen . . . . .	24
14	Refrigerant Addition output screen . . . . .	24
15	The RMS Level 2 Main Menu . . . . .	27
16	Sample run—old chiller description . . . . .	30
17	Sample run—new chiller description . . . . .	31
18	Sample run—old chiller refrigerant recovery . . . . .	31



19	Sample run—new chiller refrigerant addition . . . . .	33
B1	Level 1 program flow chart . . . . .	38
B2	Level 2 program flow chart . . . . .	39

# 1 Introduction

## Background

Since the signing of the Montreal Protocol on Chlorofluorocarbons (CFCs) (26 I.L.M. 1541 [1987]), several policies and regulations have come into effect to reduce the impact that ozone-depleting substances have on the environment. In particular, CFC refrigerants have been targeted for phaseout by 1 January 1996 by the 1992 Copenhagen Amendments to the Protocol (32 I.L.M. 874 [1993]) and by the U.S. Environmental Protection Agency (USEPA) (58 FR 65018), as provided for under the U.S. Clean Air Act Amendments of 1990 (Public Law [PL] 101-549) and announced by former President George Bush in February 1992 (58 FR 15017).

Other regulations and policies directly affect the operations and maintenance (O&M) practices of air conditioning and refrigeration (AC/R) equipment that depends on CFCs. One of these is a prohibition by the 1990 Clean Air Act Amendments, section 608 c (1), of the venting during servicing, repair, and disposal of these ozone-depleting substances, effective 1 July 1992 (Public Law [PL] 101-549). A USEPA regulation on refrigerant recycling requires owners/operators of AC/R equipment to maintain records of service calls and amounts of refrigerant added to machines, effective 14 June 1993 (58 FR 28701).

Part of the policy established by Department of Defense (DOD) Directive 6050.9 on CFCs and halons seeks to decrease dependence on CFCs and halons by developing a tracking system to document the DOD's annual requirements for these substances. This means that each Army Major Army Command (MACOM) is required to report annually the procurement of these regulated substances by type, use, and quantity (Headquarters, Department of the Army [HQDA] Letter 200-90-1, July 1990). The DOD Directive and the HQDA Letter mandate that refrigerant use be recorded during all O&M activities.

Presently, no refrigerant inventory data base exists, nor is there a system to record refrigerant recoveries from AC/R equipment or their subsequent storage in a refrigerant stockpile. The current practice is for service contractors to record refrigerant additions to AC/R equipment in quarterly inspection reports, which are then sent to an installation's Quality Assurance (QA) branch. A typical Army

installation uses different contractors to service different types of AC/R equipment. For example, one service contractor may inspect large chillers, another will service household equipment, while a third works on commissary refrigeration equipment. Each contractor provides separate individual inspection reports to the QA Branch. A need exists for a refrigerant management system to consolidate and properly track refrigerant consumption in AC/R equipment and to help prioritize the use of these targeted substances on Army installations.

In this study, the U.S. Army Construction Engineering Research Laboratories (USACERL) created a computerized refrigerant inventory system to provide owners of AC/R equipment with a tool to track refrigerant additions and recoveries. The *Refrigerant Management System (RMS)* consists of two modules, "Level 1" and "Level 2." Level 1 identifies AC/R equipment by installation name, building number, and chiller serial number. This module also records the type of refrigerant the equipment uses, identifies the type of refrigerant transaction performed on the machine (addition or recovery), and accounts for the refrigerant's source and its destination after conclusion of service. The resulting data base provides a complete history of refrigerant service transactions performed on any given AC/R machine. This information can be automatically manipulated in *RMS* Level 2 to help AC/R equipment owners control and prioritize maintenance schedules, report refrigerant consumptions, and manage the in-house refrigerant stockpile. *RMS* is currently being field-tested; feedback will be incorporated into the final version of the program.

## Objectives

The objectives of this work were to: (1) develop a computerized refrigerant inventory system that tracks refrigerant additions and recoveries in AC/R systems at Army installations, and (2) provide a refrigerant inventory data base for inventory control, reporting, and management as dictated by the EPA regulations and DOD Directive 6050.9.

## Approach

1. Laws and regulations pertaining to CFC use were reviewed.
2. Current O&M of AC/R equipment on Army installations was investigated.
3. The gathered information was analyzed to determine the data that installation personnel must maintain to build complete records of refrigerant service transactions on AC/R machinery sufficient to satisfy governing laws and regulations.

4. An appropriate programming platform (Quick-Basic®) was selected for programming simplicity and easy portability between common, IBM-compatible, personal computer (PC)-based platforms.
5. The *Refrigerant Management System* was programmed in two modules to reflect the logical division between the necessary steps of the *RMS* information process: data collection and report generation.

## Scope

*RMS* was written to simplify the recordkeeping processes required of Army installation personnel by current laws and regulations, which require CFCs to be gradually phased out of use. Level 1 of the *RMS* includes a way to record refrigerant changes in a piece of equipment due to any retrofit work done on the equipment. For example, if a piece of equipment is retrofitted to use another type of refrigerant, *RMS* Level 1 makes it possible to continue to track the refrigerant service on the machine. Level 2 produces reports on current AC/R equipment totals by recording refrigerant type and periodic refrigerant consumption for the entire installation, specific buildings, or specific chillers.

## Mode of Technology Transfer

A Public Works Technical Bulletin (PWTB) regarding the CFC Phaseout Program is planned for publication by the U.S. Army Center for Public Works (USACPW), Alexandria, VA in fiscal year (FY) 1995. Availability of *RMS* will be advertised through publications by the USACPW, such as the *Public Works Digest* and the planned PWTB.

*RMS* will also be available free of charge to Army installations on request from the following USACERL point of contact:

Dr. Chang Sohn

U.S. Army Construction Engineering Research Laboratories (USACERL)

PO Box 9005

Champaign, IL 61826-9005

COM: 217/352-6511 (in Illinois) or 1-800/USACERL (outside Illinois)

FAX: 217/373-7222

## 2 RMS Level 1 Program

### Program Overview

The Level 1 Refrigerant Management System software is a simple computer program written in Quick-Basic for the continuous logging of refrigerant services performed on AC/R equipment in Army facilities.

When Level 1 is executed, the user has the option to identify a new chiller or an existing chiller. For this identified chiller, the user may input, delete, view, or edit refrigerant service transactions. These transactions consist of refrigerant recovery, refrigerant addition, and both refrigerant recovery and addition. The program allows the user to view, save, or print out the input data base information. The user exits the program by selecting the EXIT command from the Main Menu. A flow chart of the entire program structure is given in Appendix B

### Program Requirement

#### *System Environment*

The Level 1 program requires an IBM PC/XT/AT system or a compatible with at least 640K random access memory (RAM).

#### *System Installation*

The following files are required to run Level 1:

- LEVEL1.EXE (the executable program file)
- ASCVT.EXE (the executable file to convert the Level 1 output file to ASCII)
- README (the file containing important instructions for running the program).

Although the program may be run from either a floppy or a hard disk, the program will run more efficiently from a hard drive. It is strongly recommended that a backup copy of the program be made before installation:

1. Make a new directory on the hard disk (example: MKDIR RMS)
2. Copy all files on floppy diskette to the new directory (example: COPY B:\\*.\* C:\RMS\\*.\*)
3. Add a line for path command in the AUTOEXEC.BAT file to execute the program in any directory (PATH C:\RMS).

## Input Management

Since the program requires the user to input much data, the program uses procedures that work to guarantee safe data input in three ways:

1. The program simplifies input through menu lists, i.e., the user inputs data by selecting entries from a menu rather than by typing the data in. This reduces the chances of typographical error. Also, available "Help" screens describe each menu item to assist the user in selecting appropriate items from the menu lists.
2. A series of built-in routines help prevent typos as data is entered. The routines check the typed data to see if it corresponds with the acceptable format for the program. If an apparent typing error is found, the routine displays a warning screen to prompt the user to re-enter the data in an acceptable format.
3. At the end of a transaction, the program displays all the data entered in the transaction in a series of output screens. This gives the user the opportunity to doublecheck the data before saving the transaction. Should the user save some wrong data, the program provides an option in the Main Menu to modify the entered data, i.e., the EDIT A TRANSACTION option.

After data is saved for the first time, an output file (C:\RMS\RMS.OUT) and a sub-directory (C:\RMS) for the output file are automatically created by the program. All output data will be stored in this file. **Do not delete this file from the C:\RMS directory. Removing this file in the directory will cause all output data to be lost.** The data in this file cannot be manipulated in any way. The only way to handle the output file and to protect it is to back up (i.e., copy) the output file to another directory or diskette. It is strongly recommended that the output file be saved to a diskette as your backup file after each transaction.

Note that the automatically generated output file C:\RMS\RMS.OUT is not in ASCII format. The execution file, ASCVT.EXE, is provided to convert the format of output file into an ASCII file. Executing ASCVT.EXE will create a second output file, C:\RMS\ASCRMS.OUT, which is a duplicate output file of RMS.OUT, but in ASCII

format. This ASCII text file may be viewed or edited in any text or word processor. Note that ASCVT.EXE considers C:\RMS\RMS.OUT as an input file. Make sure the RMS.OUT file is available to ASCVT.EXE before running the conversion program.

## Running the Program

### *Getting Started*

To begin the program, type the execution filename (LEVEL1) from the drive and subdirectory where the program resides (or at the C: prompt if you have entered the program's path into the path statement in the C:\AUTOEXEC.BAT file). The opening screen displays the USACERL logo identifying the program, and prompts the user to "Strike any key to continue."

### *Entering Input*

The Main Menu follows the opening screen (Figure 1). A detailed description of the Main Menu options follows.

The ADD A NEW CHILLER option (Figure 2) allows the user to input general information about a chiller into the data base. This general chiller information must be entered for each chiller before any refrigerant service transactions can be entered. The information needed for the data base are: the installation name, the building number where the chiller is located on the installation, the chiller identification

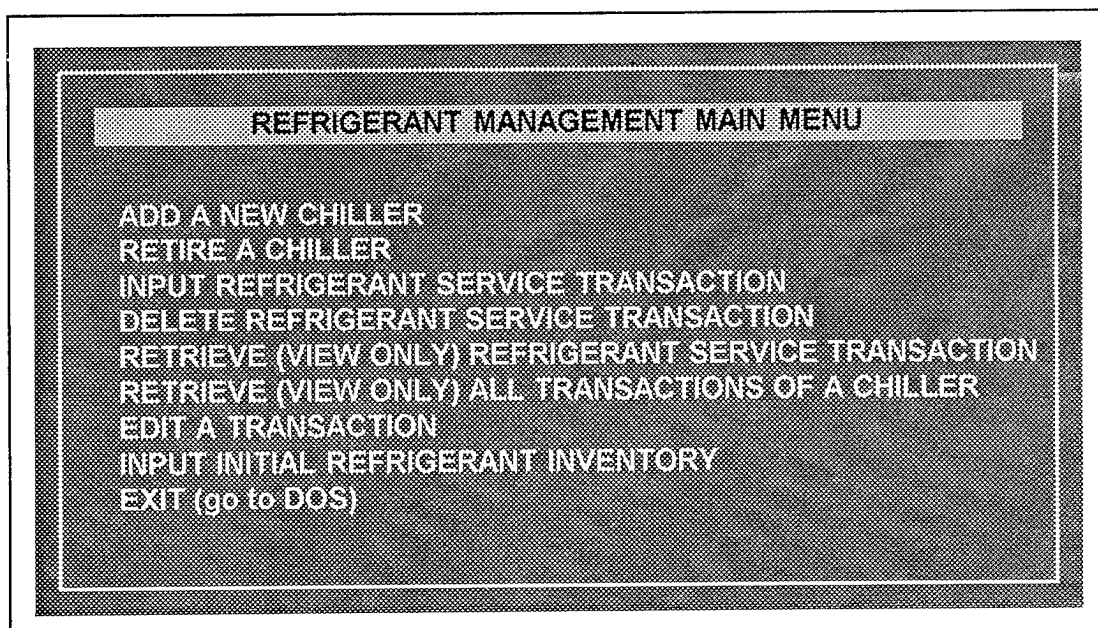


Figure 1. The RMS Level 1 Main Menu.

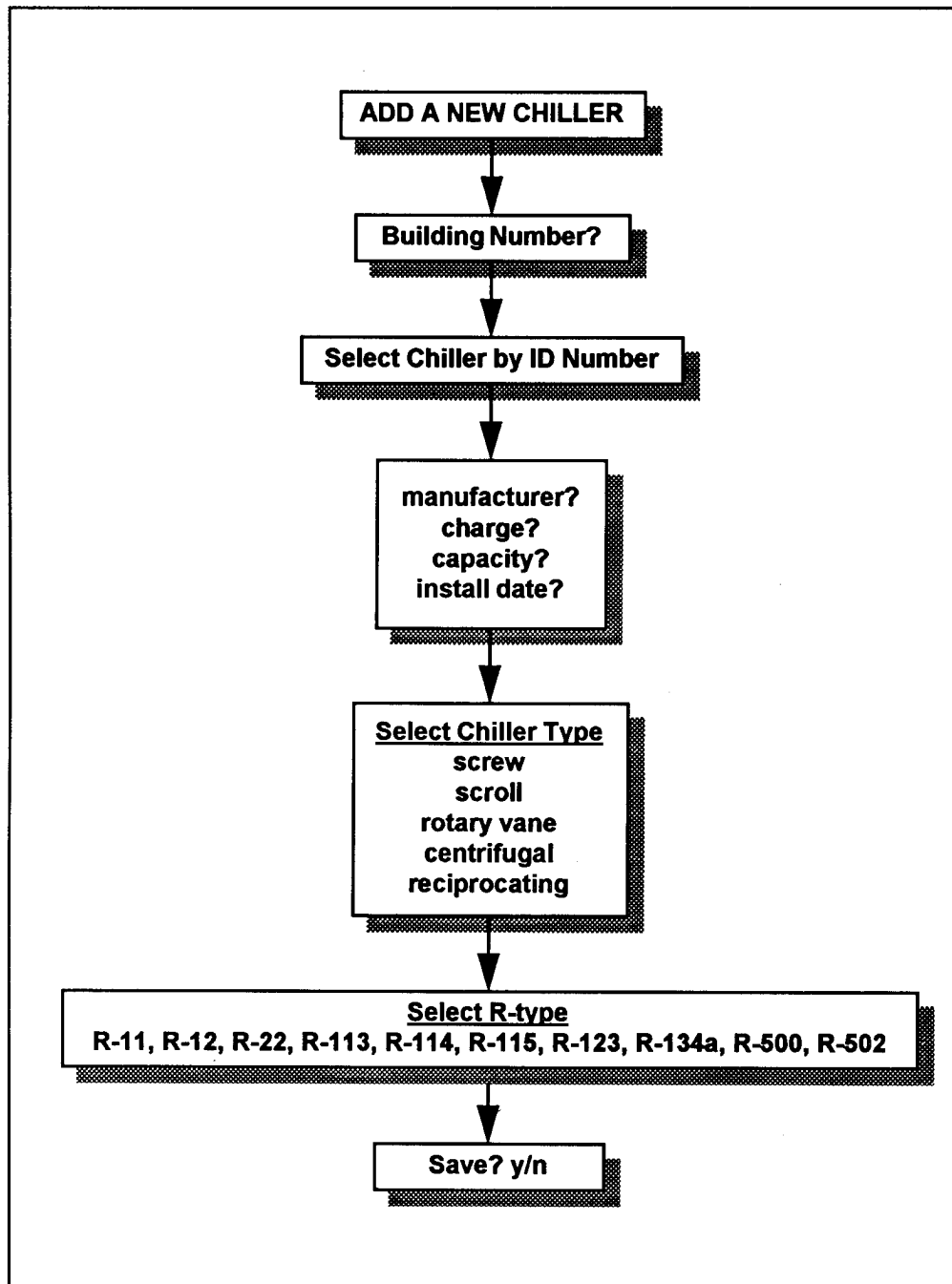


Figure 2. Flow chart for ADD A NEW CHILLER menu option.

number, the type of chiller, the chiller manufacturer, the type of refrigerant used by the chiller, the amount (pounds) of refrigerant the chiller is charged with, the capacity of the chiller (tons), and the installation date.\* (This Main Menu option allows the user to SAVE the entered information, but does not offer a chance to PRINT this information.)

\* 1 lb = 0.453 kg; 1 ton (of refrigeration) = 3.516 kW.



The user's installation name should be included on the list of names provided by the menu. If a specific installation name is apparently missing, try to search for the installation name in as many possible ways as it could be listed. For example, if the installation name is "Fort Leonard Wood" and a search for the name under "l" comes up empty, try looking for it under "w." If the installation name begins with a number, such as 125th USARCOM or 7th ATC HQ, search for it under "1" or "o" for one or "7" or "s" for the number seven. Should the installation name not be listed, then enter the character "#" for the name and continue with the following direction the program provides.

The chiller identification number should be entered in very carefully and should preferably be the serial number on the chiller nameplate. However, another form of identification may be used, provided that the entered form of identification is used consistently with all the chillers on that particular installation.

For the type of chiller, select from either screw, vane, rotary vane, centrifugal, or reciprocating type of compressor. Usually the manufacturer includes the compressor type in the name of the chiller (e.g., "McQuay Centrifugal Single Compressor Packaged Water Chiller," or "York Codepak Rotary Screw Liquid Chillers").

The amount of refrigerant the chiller is charged with should be the original charge that the manufacturer provides with the new chiller. This original charge should also be the total charge needed to run the chiller. Since this original amount is recorded here in the ADD A NEW CHILLER section, it is not necessary to record this original amount also in the INPUT A REFRIGERANT SERVICE TRANSACTION under Refrigerant Addition.

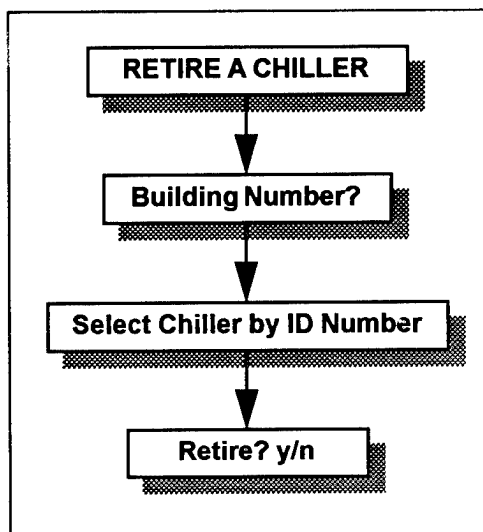


Figure 3. Flow chart for RETIRE A CHILLER menu option.

The Main Menu option RETIRE A CHILLER (Figure 3) allows the user to record when a chiller is taken out of service. This means that the information entered in the ADD A NEW CHILLER Main Menu option will now be flagged as pertaining to a retired unit. Retiring a chiller from the data base will not delete any refrigerant service transactions recorded for this chiller in the data base. However, it will not allow any further transactions to be recorded for this chiller since the chiller information is retired. (This Main Menu option allows the user to SAVE, but not to PRINT this information.)

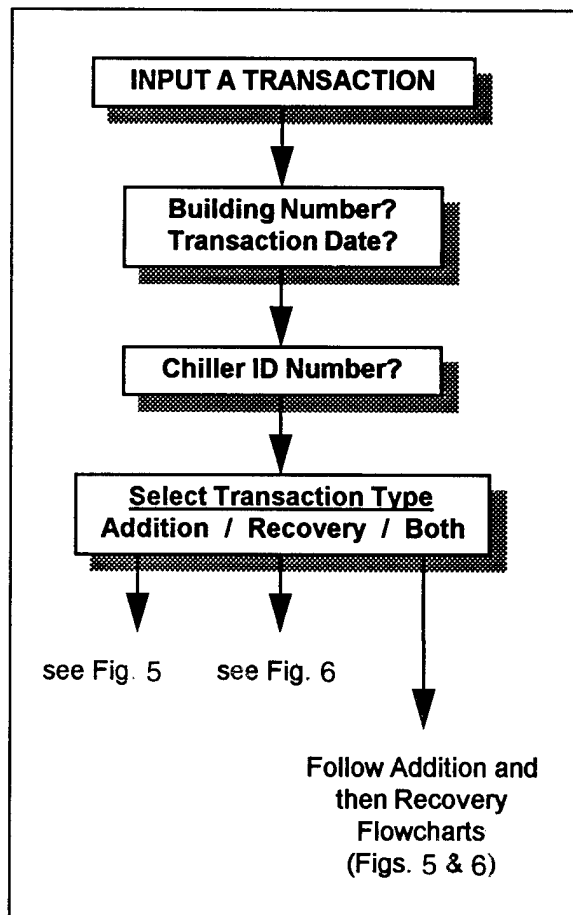


Figure 4. Flow chart for INPUT A TRANSACTION menu option.

The INPUT A REFRIGERANT SERVICE TRANSACTION selection (Figure 4) allows a refrigerant service transaction to be recorded for a chiller already in the data base. If the chiller is not already in the data base, select ADD A NEW CHILLER from the Main Menu and first provide the needed information, then select INPUT A REFRIGERANT SERVICE TRANSACTION. (The information provided in this Main Menu option can be both PRINTED and SAVED.)

To input a refrigerant service transaction, the user first must identify the installation name and the building number where the chiller is located. Then a chiller identification number is selected from a list. Once the chiller is identified, the program prompts the user for the type of transaction to be recorded.

Three types of refrigerant service transactions may be entered: (1) Refrigerant

Addition, (2) Refrigerant Recovery, and (3) Refrigerant Recovery and Addition. A Refrigerant Addition transaction would be recorded when the chiller is charged with refrigerant, as in maintenance charges. Refrigerant Recovery should be selected when any amount of the refrigerant in the identified chiller is removed for any reason (e.g., maintenance work, chiller replacement, chiller retrofit, etc.). The Refrigerant Recovery and Addition transaction should be selected when refrigerant is both removed and added back to the same chiller in the same day.

For example, if refrigerant is added, select the Refrigerant Addition transaction (Figure 5) and provide the following information to record this transaction:

1. Verify the type of refrigerant being added to the chiller. Select "Y" for "yes" if the refrigerant indicated on the screen is the same type being added to the chiller. Select "N" for "no" if the refrigerant indicated is not the type of refrigerant being added to the chiller.
2. Record the amount of the charge (in pounds).

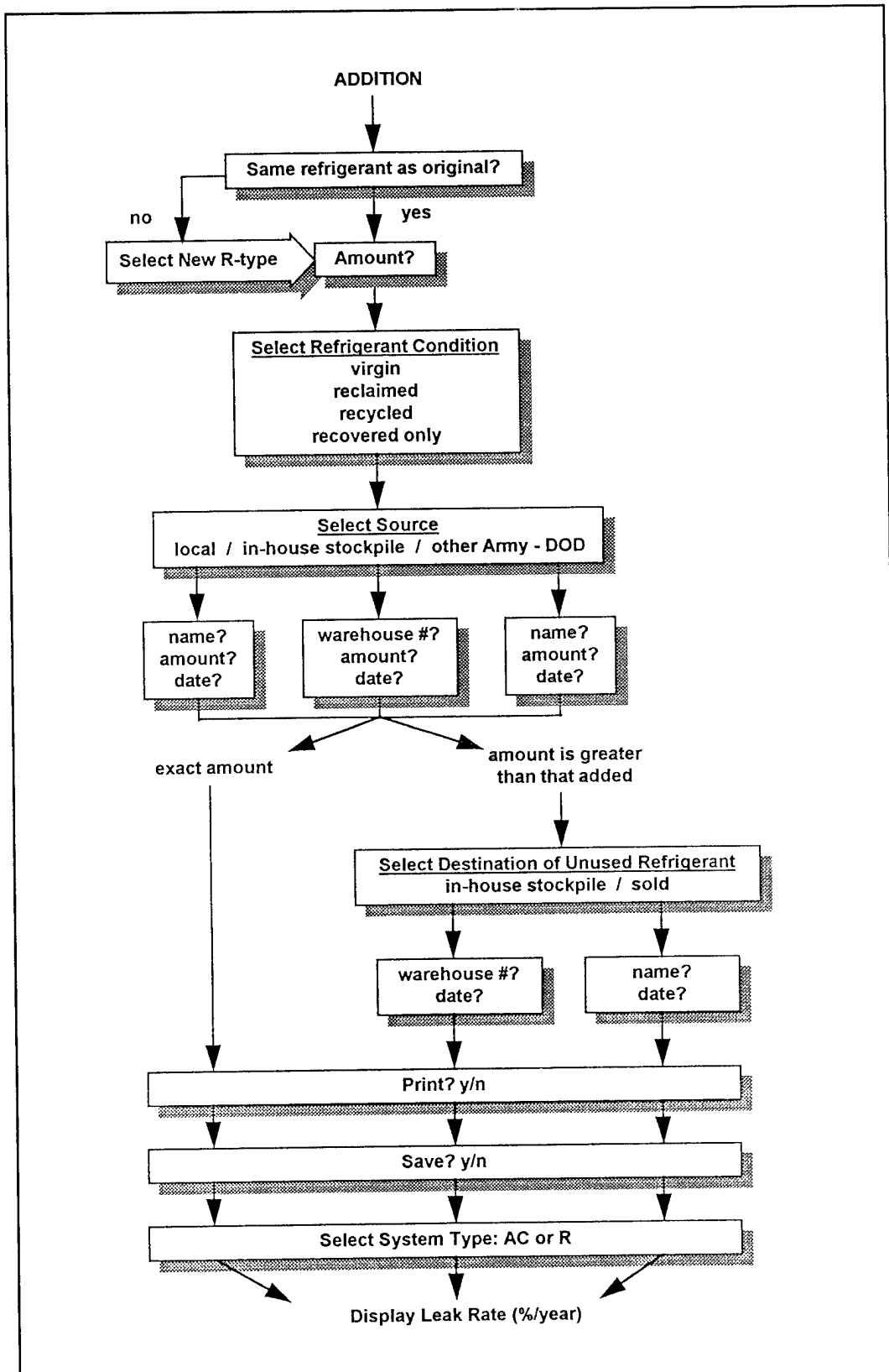


Figure 5. Flow chart for Addition Transactions.

3. Identify the condition of the refrigerant being added to the chiller. (Appendix A explains the different refrigerant conditions.)
4. Identify the source of this refrigerant. This source could be a local supplier or contractor, the in-house stockpile (refrigerant storage area), or another Army facility or Department of Defense (DOD) installation (i.e., an Air Force or Navy facility).
5. Identify the name of the source.
6. Identify the amount obtained from the source.
7. Identify the date this amount was obtained from the source.

All of this information will be needed for the Refrigerant Addition transaction.

Also, if the amount of refrigerant obtained from the source is greater than the amount added to the chiller, a record of the unused amount and where this unused amount was stored will also need to be recorded by this transaction. For example, assume 2000 lb of refrigerant is obtained from company XYZ. Of that 2000 lb, only 1200 lb are used to charge a chiller. The remaining (unused) 800 lb and the storage location of this unused amount must also be recorded. The Refrigerant Addition transaction of this program will prompt the user for this information.

If refrigerant is recovered from a chiller, select the Refrigerant Recovery transaction (Figure 6) and provide the following information to record this transaction. First, indicate the amount (in pounds) recovered. Second, specify the treatment of this recovered refrigerant. This treatment of the recovered refrigerant must be recorded as one of the following: disposed, recovered only, recycled, or reclaimed. (Appendix A explains these refrigerant conditions.) Third, identify how the recovered refrigerant was stored. If the recovered refrigerant is stored in house (i.e., a refrigerant stockpile somewhere on the installation), then the date and amount placed in the stockpile will be recorded by this transaction. If the refrigerant is sold, then this refrigerant recovery transaction will require the name of the buyer organization, the amount sold (in pounds), and the date of sale. All this information is necessary to properly record refrigerant recovery from a chiller.

Finally, if refrigerant is recovered and added back to the same chiller in the same day, then select the Refrigerant Recovery and Addition transaction. This option should be selected even if a different type of refrigerant is added to the chiller (e.g., in a retrofit). This transaction guides the user first through the recovery process, then through the addition process. The user will have to provide information on both the refrigerant

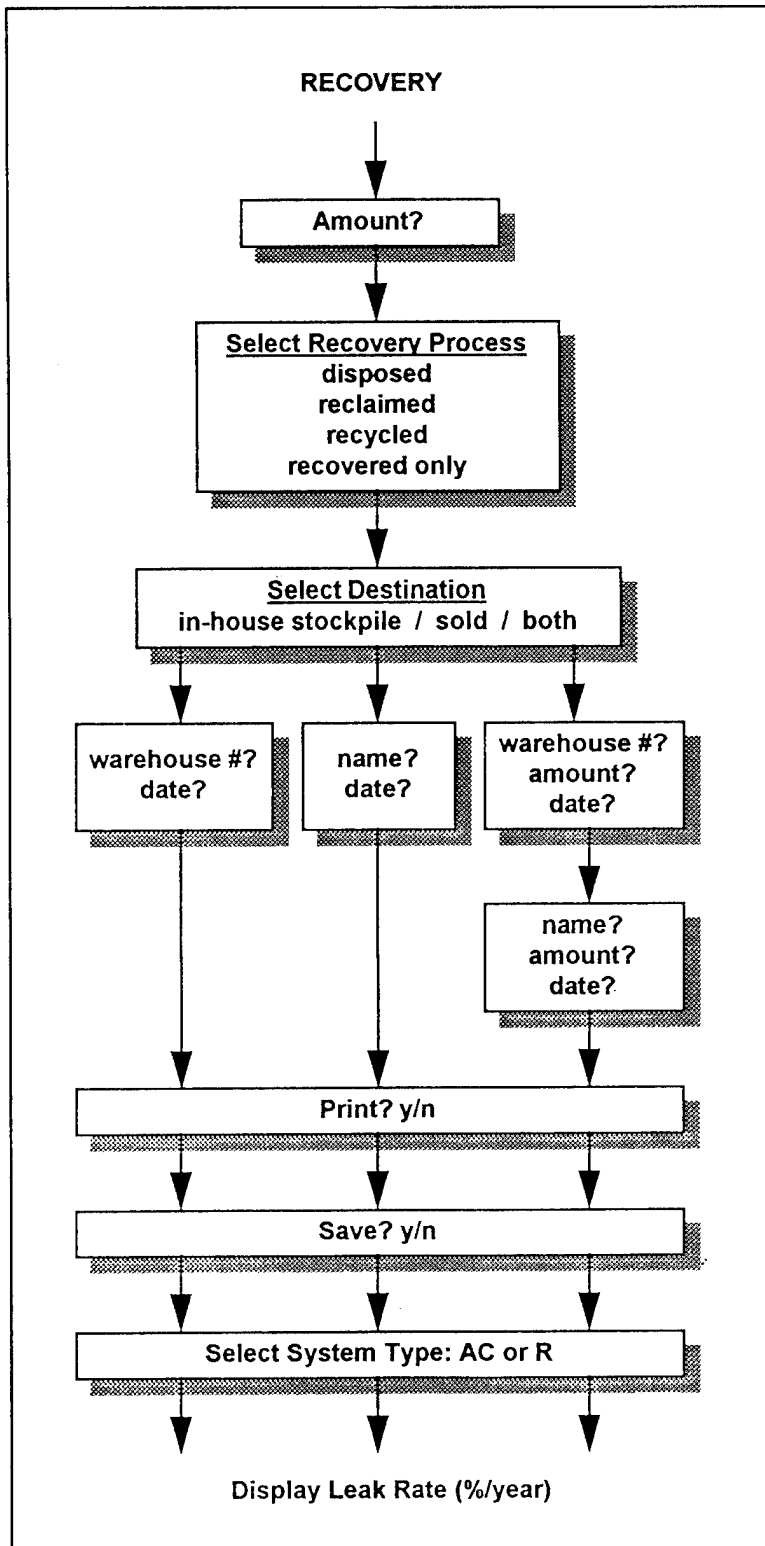


Figure 6. Flow chart for Recovery Transactions.

recovery and the refrigerant addition transactions.

The last input requested at the end of both types of transactions is the type of system the particular piece of equipment operates, either air-conditioning or refrigeration. After the system has been identified, the program displays a calculated leak rate for that unit in percent per year and will alert the user if this rate exceeds the regulated amounts.

The Main Menu option DELETE A REFRIGERANT SERVICE TRANSACTION (Figure 7) allows a refrigerant service transaction to be deleted for a chiller already in the data base. To locate the chiller in the data base, the installation name and the building number where the chiller is located will have to be provided. Once this information is provided, the desired chiller can be selected from a list that will appear on the screen. When a chiller is selected, a subsequent listing of transactions for the chiller appears. The user may select the appropriate transaction(s) to delete

from this list. The user will be asked to confirm (SAVE) this desire with a "Yes" or "No" to delete a selected transaction. (There is no option to PRINT with this Main

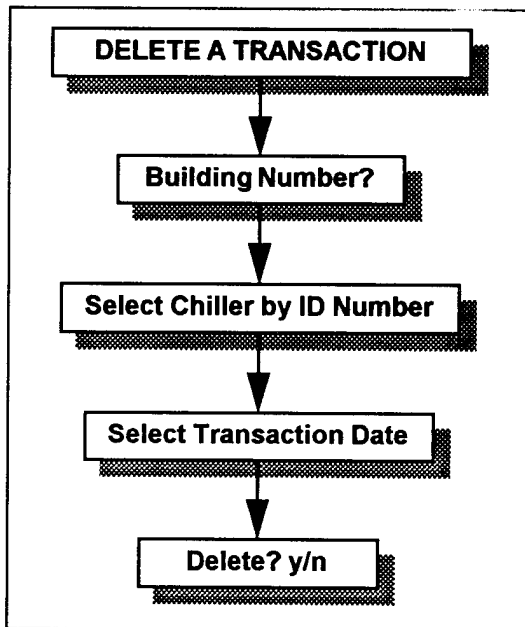


Figure 7. Flow chart for DELETE A TRANSACTION menu option.

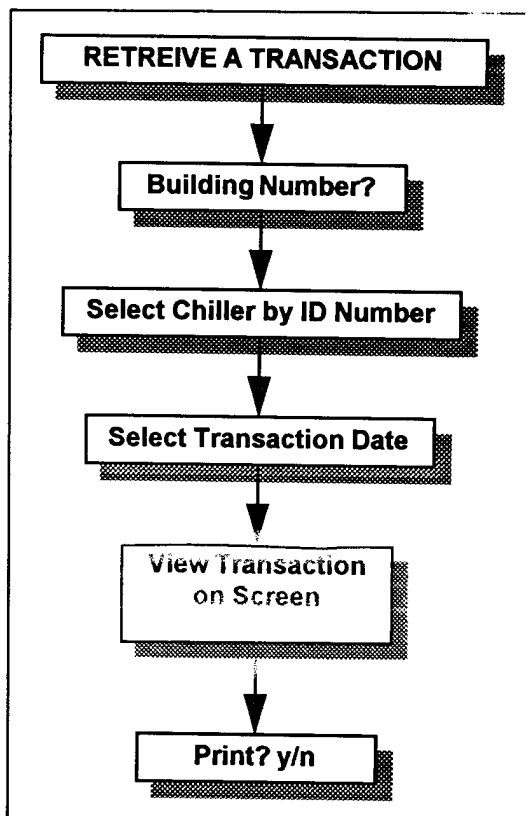


Figure 8. Flow chart for RETRIEVE A TRANSACTION menu option.

Menu option.) Once this transaction is completed, the user is returned to the Main Menu.

The Main Menu selection RETRIEVE (VIEW ONLY) REFRIGERANT SERVICE TRANSACTION (Figure 8) allows the user to retrieve a refrigerant service transaction for a particular chiller. Before any transaction can be retrieved, a transaction must already be recorded in the data base for the particular chiller. A transaction is recorded into the data base through the Main Menu option, INPUT A REFRIGERANT SERVICE TRANSACTION. (The Main Menu option ADD A NEW CHILLER does not record a refrigerant transaction; it only inputs a chiller into the data base.) If no transactions are recorded for the chiller, this option will not work because there are no transactions to retrieve.

To access the desired transaction, the installation name, building number, and the chiller identification number will need to be entered first. These are selected from the "Enter First Letter of Your Installation Name," "Enter Building Number," and "Select A Chiller You Want" screens, respectively. If the desired chiller identification number does not appear on the "Select A Chiller You Want" screen, then no refrigerant transactions have been entered for this chiller, and, therefore, no transactions can be retrieved. Once a chiller identification number is selected, the user may choose the transaction to be viewed from a list of transaction dates (from the "Select A Refrigerant Service Date You Want" screen). This option does not allow any changes to the transaction to be made. To make changes to a transaction, see the EDIT A TRANSACTION Main Menu option.

This view-only Main Menu option does offer a chance to PRINT the displayed information. To print this information, an output filename needs to be given. This

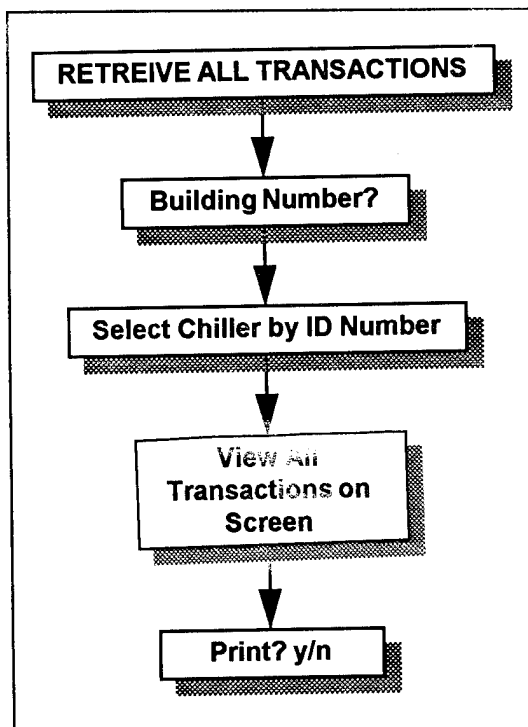


Figure 9. Flow chart for RETRIEVE ALL TRANSACTIONS menu option.

should be given in the following format: C:\FILENAME or D:\FILENAME. Although the filename may be any DOS filename the user desires, the drive specified, C:\ or D:\, in this example, should be the drive where the program resides.

The RETRIEVE (VIEW ONLY) ALL TRANSACTIONS OF A CHILLER option (Figure 9) allows the user to retrieve all refrigerant service transactions for a particular chiller, providing a service history for the chiller. The user must identify the installation name, the building number where the chiller is housed, and the chiller identification number with this Main Menu option. Once this information has been entered, the program will indicate the number of transactions for this chiller with a screen that reads, "There are # refrigerant

transactions. You can see the history of all transactions in the following page." (The "#" will actually be the number of transactions to be viewed.) The next series of screens give information on the chiller description, all refrigerant service transactions recorded for this chiller, and a summary of the transactions. This summary will give the total amount of refrigerant added to this chiller (in pounds), the total amount of refrigerant recovered, and the total amount of refrigerant leaked.

Once this information is viewed, the user may print the data by providing an output filename. (Make sure a printer is available). The above RETRIEVE (VIEW ONLY) REFRIGERANT SERVICE TRANSACTION option (above) explains how to provide an output filename. No changes to the transactions can be made by this Main Menu option. See the Main Menu option, EDIT A TRANSACTION to make changes to a transaction.

The EDIT A TRANSACTION menu option (Figure 10) allows the user to make changes to a refrigerant service transaction for a chiller in the data base. Note that this option does not allow the user to edit any chiller information, only the refrigerant service transactions related to this chiller. To edit any chiller information, select the Main Menu option ADD A CHILLER and start over. In order to edit a transaction, the installation name, building number where the chiller is housed, and chiller identification number will be needed to access the desired transaction. Once changes are made to a transaction, the user will be prompted whether to save the changes. Select "Yes"

to save the changes, or "No" to leave the transaction as it was. The user will also have an opportunity to PRINT this information.

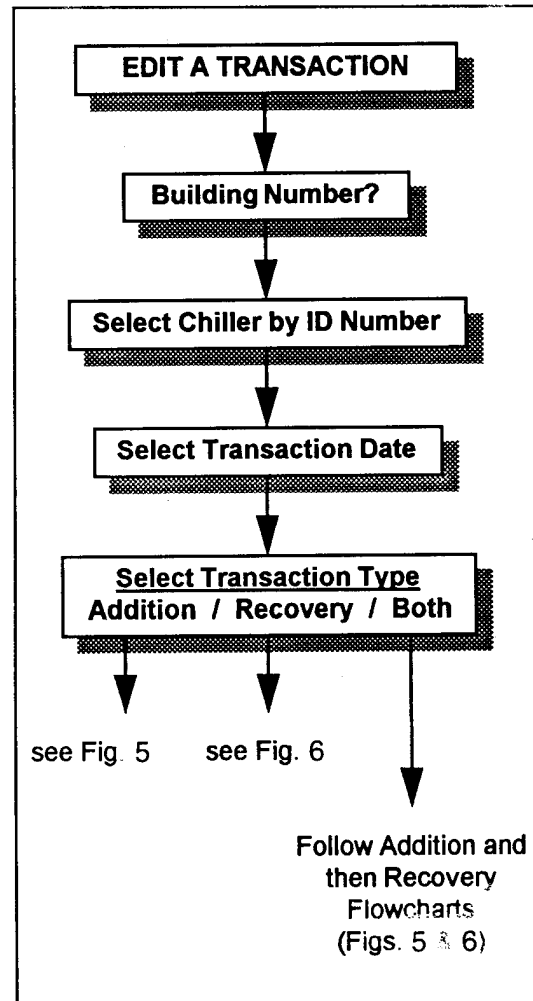
The INPUT INITIAL INVENTORY menu option (Figure 11) allows the user to enter initial amounts of all refrigerants in the inventory of the installation. This one-time procedure is meant to be done when this software is first put to use. Choose this option to record the amount and type of refrigerants already in your stockpile at the time of installing this software in your computer. This option stores the total amount of refrigerants for later manipulation with Level 2 software.

The EXIT (Go to DOS) Main Menu option allows the user to quit the program and return to DOS.

### ***Program Execution***

The following steps outline the program execution:

1. Change current directory to the one containing the file LEVEL1.EXE, or insert the program disk into a disk drive. (If you have entered the path for the program file into the path statement in your AUTOEXEC.BAT file, neglect this step)
2. Type LEVEL1 and press Enter. The opening screen will appear displaying the USACERL logo and the title of the program.
3. Press any key to continue. The Main Menu will be displayed.
4. Select an option from the Main Menu using the arrow keys. Press the RETURN (or ENTER) key to perform the desired function.



**Figure 10. Flow chart for EDIT A TRANSACTION menu option.**



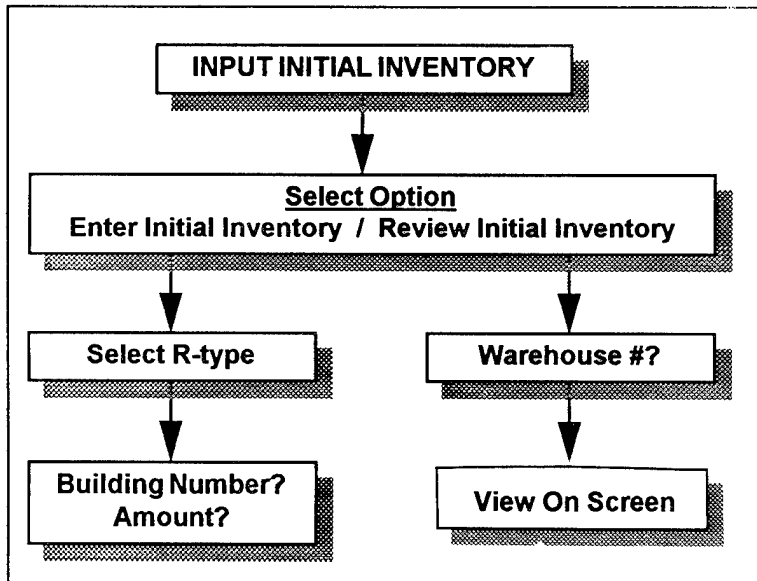


Figure 11. Flow chart for INPUT INITIAL INVENTORY menu option.

5. Enter the input information as requested by the menu. After each input entry, press the RETURN (or ENTER) key. Press the ESC key to record the input data and to continue to the next screen.
6. Use the arrow keys to select "YES" to save the input information into the program. Press the RETURN (or ENTER) key to save the data and return to the Main Menu. (Select the "NO" key if the input information is not to be saved.)
7. Move the cursor to the EXIT Main Menu option and press the RETURN key to quit the program. This will return the user to the DOS command line prompt.

## Output Management

After the input information has been entered, the program will display the input data on one or more output screens for your review. Check the input data for accuracy and press any key to proceed to the next screen. The user will be prompted whether to PRINT the information on the output screens and then whether to SAVE the information. Note that *only* the following Main Menu options offer the PRINT option: INPUT A REFRIGERANT SERVICE TRANSACTION, RETRIEVE (VIEW ONLY) A REFRIGERANT SERVICE TRANSACTION, RETRIEVE (VIEW ONLY) ALL TRANSACTIONS OF A CHILLER, and EDIT A TRANSACTION. Use the arrow keys to select "YES" or "NO" to PRINT and/or SAVE the information, and then press the RETURN (or ENTER) key. For the PRINT option, make sure a printer is available before choosing to print the output screens.

## Discussion of Output

The Level 1 RMS program produces one to three output screens, all of which can be printed out. The first output screen is CHILLER DESCRIPTION (Figure 12), which gives a description of the chiller according to the information provided. Included in the description are:

- the name of the Army installation
- the building number where the chiller is located
- the chiller identification number
- the type of unit
- the manufacturer
- the refrigerant type used by the machine
- the total system charge in pounds
- the system capacity in tons
- the date the chiller was installed.

The second output screen will display information on the REFRIGERANT SERVICE performed on the machine. The second output screen will display information for either Refrigerant Recovery or Refrigerant Addition, depending on what refrigerant service transaction was entered. If the refrigerant service transaction entered was for Refrigerant Recovery (Figure 13), the following information will be displayed in the second output screen. First will be the type of refrigerant recovered, then the amount removed will appear. Then, the condition of the refrigerant will indicate what was done to the refrigerant after it was removed from the chiller. Also appearing on the second screen will be information on the destination of the refrigerant after it was recovered, such as where it was stored, the amount, and date stored.

If the service transaction recorded was for Refrigerant Addition, then the second output screen (Figure 14) will display the following:

- the type of refrigerant added to the chiller
- the amount of the charge
- the condition of the refrigerant added

```
=====
REVIEW THE REFRIGERANT INVENTORY DATA
=====

**** CHILLER DESCRIPTION ****

NAME OF ARMY INSTALLATION:
BUILDING NUMBER:
REFRIGERANT SERVICE DATE:

CHILLER ID:
TYPE OF CHILLER:
MANUFACTURER:
REFRIGERANT TYPE:
TOTAL SYSTEM CHARGE (LBS.):
SYSTEM CAPACITY (TONS):
INSTALLATION DATE (MM/DD/YY):
```

Figure 12. Chiller Description output screen.

```
**** REFRIGERANT SERVICE****  
  
---- REFRIGERANT RECOVERY ----  
  
REFRIGERANT TYPE:  
AMOUNT OF CHARGE (LBS.):  
CONDITION OF REFRIGERANT:  
  
=== REFRIGERANT DESTINATION ===  
<destination>  
DATE:
```

Figure 13. Refrigerant Recovery output screen.

```
**** REFRIGERANT SERVICE****  
  
---- REFRIGERANT ADDITION ----  
  
REFRIGERANT TYPE:  
AMOUNT OF CHARGE (LBS.):  
CONDITION OF REFRIGERANT:  
REFRIGERANT SOURCE:  
STOCKPILE BUILDING NUMBER:  
DATE TAKEN FROM STOCKPILE :
```

Figure 14. Refrigerant Addition output screen.

- the source of the refrigerant (i.e., in-house stockpile, local supplier, or other Army/DOD facility)
- the amount obtained from this source
- the date this amount was supplied
- the name of the supplier.

The third output screen will also display REFRIGERANT SERVICE information. It will provide information on refrigerant addition if the service performed was both Refrigerant Recovery and Addition on the same chiller on the same day, and the recovery information. There will be no third output screen when the refrigerant service transaction selected is either Refrigerant Recovery or Refrigerant Addition.

### 3 RMS Level 2 Program

#### Program Overview

The Level 2 Refrigerant Management System software, also written in Quick-Basic, is designed to interface directly with the output file from Level 1. The primary objective of Level 2 is to assist personnel in reviewing installation-wide refrigerant inventory and in preparing summary reports on refrigerant usage for the installation, a specific building, or a specific chiller. From the Main Menu, the user has a choice of four different types of reports to output:

1. **CURRENT AC/R EQUIPMENT TOTALS**, which outputs number of units, total capacity (tons), total pounds of refrigerant in equipment, and total pounds of refrigerant in the stockpile. All these categories are listed according to refrigerant type.
2. **PERIODIC REFRIGERANT REPORT FOR INSTALLATION** outputs the total pounds of refrigerant added to and recovered from equipment, the number of new units placed on line and their total cooling capacity, and the number of old units retired and their total capacity over a specified period of time. All these categories are for the entire installation and are listed by refrigerant type.
3. **PERIODIC REFRIGERANT REPORT FOR A SPECIFIC BUILDING** gives the same output as the second report, except that it lists totals for a specific building only. Output categories automatically show up for only the refrigerants present in that particular building.
4. **PERIODIC REFRIGERANT REPORT FOR A SPECIFIC CHILLER** lists the pounds of refrigerant added to and recovered from a specified chiller over a chosen period of time. Appendix B includes a Level 2 program flow chart.

## **Program Requirement**

### ***System Environment***

The Level 2 program also requires an IBM PC/XT/AT system or a compatible with at least 640K random access memory (RAM).

### ***System Installation***

Follow the system installation instructions for Level 1 before proceeding to install Level 2 software. Although the program may be run from either a floppy or hard drive, the program will run more efficiently from a hard drive. It is strongly recommended that a backup copy be made before installing the program. The executable program file, LEVEL2.EXE, should be copied to the directory where LEVEL1.EXE resides. Add a path statement to the AUTOEXEC.BAT file to execute the program in any directory (PATH C:\RMS) if you have not already done so.

## **Running the Program**

### ***Getting Started***

To begin the program, type the execution filename, LEVEL2 from the drive and subdirectory where the program resides, or from the C:\ prompt if you have entered the program path for that in the C:\AUTOEXEC.BAT file. The opening screen displays the USACERL logo identifying the program and prompts the user to "Strike any key to continue."

### ***Entering Input***

The Main Menu screen (Figure 15) follows the opening screen. A detailed description of the Main Menu options follows.

The CURRENT AC/R EQUIPMENT TOTALS menu option lists:

- number of units
- total cooling capacity of those units in tons
- total amount of refrigerant in equipment in pounds
- total amount of refrigerant in stockpile in pounds
- total amount of refrigerant for entire installation.

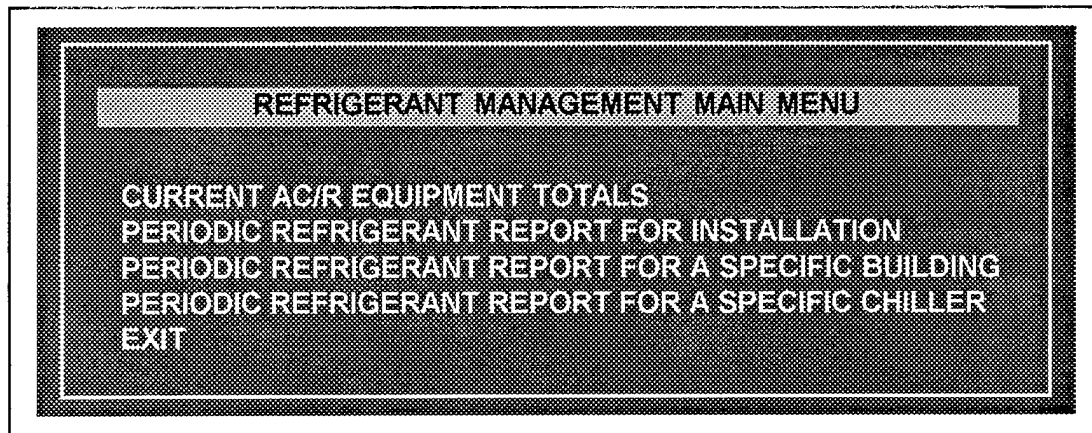


Figure 15. The RMS Level 2 Main Menu.

These data are separated in the output by type of refrigerant, therefore, a total is given for each refrigerant type requested by the user for all types present at the installation.

The PERIODIC REFRIGERANT REPORT FOR INSTALLATION option allows the user to gain information on refrigerant usage and transactions over a specified time period for the entire installation. The user specifies the time period and refrigerant type as input. The pounds of refrigerant added and recovered, the number of new units and their total capacity in tons, and the number of units retired and their total capacity in tons are listed as output.

The PERIODIC REFRIGERANT REPORT FOR A SPECIFIC BUILDING option gives the same output as the previous option, but for only a specified building and not the entire installation.

The PERIODIC REFRIGERANT REPORT FOR A SPECIFIC CHILLER option yields transaction information on a specific chiller. The user specifies the building number, the chiller ID number, and the time period. The total amount of refrigerant added and recovered from the particular chiller, and the leak rate are output.

### ***Output Management***

All output from the four menu options is automatically shown on the screen with an option to print or save to a file.

## 4 Sample Program Run

### Sample Run of Level 1 Program

A sample run of the Refrigerant Management System program was done for the case of a chiller replacement at Fort Leonard Wood, MO. A Refrigerant Recovery transaction is shown for the chiller being replaced and a Refrigerant Addition transaction is presented for the new chiller after its first year of service. Before these transactions are shown, both the old and new chillers are first added to the data base using the ADD A NEW CHILLER option from the Main Menu. This Main Menu option requires collection of the following information for both chillers:

- the installation name
- the building number where the chillers are housed
- chiller identification numbers from the chiller nameplates
- the type of chillers and their manufacturers
- the refrigerant types
- the total system capacities of each chiller
- the refrigerant charges
- the dates of their respective installation.

The Refrigerant Recovery transaction requires information on how the refrigerant was treated on recovery and where it was subsequently stored. For the Refrigerant Addition transaction, information on the source of the refrigerant and the condition of the refrigerant being added will be needed. A walk-through of the necessary steps to record this information into the data base follows.

The preliminary information available for input as data on the two chillers for this sample problem follows. The chiller being replaced was located at the Fort Leonard Wood Army installation in building 1021. The chiller was a 22-year-old, R-11, hermetic, Carrier centrifugal chiller unit. The model and serial numbers from the chiller nameplate are 19C 86U Q19 R19 and 690613472, respectively. It had a nominal capacity of 1025 ton, a refrigerant charge of 3600 lb, and a maximum power input of 820 KW. It was installed on 12 May 1970 and replaced on 12 May 1992. On 12 May 1992, the refrigerant in the old chiller was recovered before retiring the

equipment. The complete charge of 3600 lb was recovered only and sold to XYZ company on 15 May 1992.

The new chiller was installed in the same building next to the existing R-11 chiller. This new chiller was a McQuay, 655.7 ton, semi-hermetic, centrifugal chiller unit. It ran on 1190 lb of R-134a refrigerant and was designed for a maximum power input of 477 KW. Its model and serial numbers are PEH100 (shortened for simplicity) and 5XC0103300, respectively. It was installed on 15 May 1992. A year later, on 15 May 1993, the new chiller was charged with 150 lb of virgin R-134a refrigerant obtained from company XYZ on 15 May 1993. The total amount obtained from company XYZ on this day was 200 lb. Any excess refrigerant was stored in the in-house stockpile building WH1 on 15 May 1993.

With the above information available, the program runs as follows:

1. Insert the program disk into a disk drive, or change current directory to the one containing the file LEVEL1.EXE. Type LEVEL1 and press Enter.
2. The opening screen with the USACERL logo will appear. Press any key to continue to the Main Menu.
3. The screen will display the Main Menu (Figure 1). Use the arrow keys to move the highlighted cursor around the Main Menu. (Make sure the "Number Lock" key is off.) Select the ADD A NEW CHILLER option with the cursor and press Enter.
4. Enter the information for the existing (old) chiller as prompted by the menu. For the installation name, type in "w" to locate Fort Leonard Wood, press Enter and then Esc. Highlight this name on the list provided. When the highlighted cursor is on Fort Leonard Wood, press the Enter key.
5. The next screen shows the selected installation name and prompts for the building number. Type in the building number, "1021", press Enter and then Esc.
6. Enter the chiller identification number, "690613472" (carefully, as the next screen requests). Press Enter and Esc. The next screen will display the chiller ID number just entered and will ask for the manufacturer, the total system charge, the system capacity, and the date installed. At this point, the chiller ID number cannot be edited on screen. Following the instructions at the bottom of the screen, enter "Carrier" for the manufacturer, "3600" for the pounds of original



refrigerant charge, "1025" for the capacity in tons, and "5/12/70" for the year it was installed. Note that all dates in the program must be entered in the format: month/day/year. Press Enter and then Esc when finished typing in this information.

7. At the next screen, use the arrow keys to select "centrifugal" as the type of chiller and then press Enter. Select "R-11" as the proper refrigerant type for this chiller, and then press Enter. All data necessary to record a chiller into the data base has now been entered.
8. The program will now allow the user to view the information just entered (Figure 16). Review this data for accuracy and then press Enter. The user will then have the option to save this information. Select "YES" to save the information. (Select "No" only if any of the chiller information was incorrectly entered; this will delete all the chiller information for this particular chiller and allow the user to start over again with ADD A NEW CHILLER.) The program will return to the Main Menu.
9. From the Main Menu, again select the ADD A NEW CHILLER option and input similar information for the new chiller. The building number will be the same. The chiller ID number is "5XC0103300." The manufacturer is "McQuay"; the original total system charge is "1190" pounds; the system capacity is "655.7" tons; and the installation date is "5/15/92". The chiller is a "centrifugal," "R-134a" unit. Review this data for accuracy on the following output screens (Figure 17). Select "YES" to save this information. The program will return to the Main Menu.
10. Select INPUT A REFRIGERANT SERVICE TRANSACTION from the Main Menu for the case of Refrigerant Recovery from the existing chiller. Input the information as requested by the menu to record this service transaction. The installation name appears by default. Enter building number "1021" and press Enter. Type in "5/12/92" for the

```
=====
REVIEW THE REFRIGERANT INVENTORY DATA
=====
```

```
**** CHILLER DESCRIPTION ****
```

```
NAME OF ARMY INSTALLATION: WOOD FT LEONARD
BUILDING NUMBER: 1021
```

```
CHILLER ID: 690613472
TYPE OF CHILLER: CENTRIFUGAL
MANUFACTURER: Carrier
REFRIGERANT TYPE: R-11
TOTAL SYSTEM CHARGE (LBS): 3600
SYSTEM CAPACITY (TONS): 1025
INSTALLATION DATE (MM/DD/YY): 5/12/70
```

Figure 16. Sample run—old chiller description.

service date and press Enter. Press Esc. From the next screen, select the chiller ID number "690613472" and press Enter. For the desired operation, select Refrigerant Recovery and press Enter.

11. Enter "3600" pounds for the amount of refrigerant recovered, then press Enter and Esc. Using the arrow keys, select "Recovered only" to identify what was done with this recovered refrigerant and press Enter. Select "Sold" as the destination of the recovered refrigerant and press Enter.

12. The next screen will ask for information on the refrigerant that was sold. Note that the amount sold is already indicated and cannot be changed on this screen. Enter "XYZ" for the name of the organization the refrigerant was sold to, and press Enter. Enter "5/15/92" as the date the refrigerant was sold to company XYZ. Press Enter and then Esc. All the data necessary to record a Refrigerant Recovery for this chiller has been entered.

13. The program will display this entered data for the user to review prior to printing and saving this information (Figure 18).

14. Select "YES" if the output screens are to be printed simultaneously to the printer and a file. (Make sure a printer is available if the user chooses to print.) Select "YES" to save this transaction, and then press Enter for the Main Menu.

```
=====
REVIEW THE REFRIGERANT INVENTORY DATA
=====

**** CHILLER DESCRIPTION ****

NAME OF ARMY INSTALLATION: WOOD FT LEONARD
BUILDING NUMBER: 1021

CHILLER ID: 5XC0103300
TYPE OF CHILLER: CENTRIFUGAL
MANUFACTURER: McQuay
REFRIGERANT TYPE: R-134A
TOTAL SYSTEM CHARGE (LBS): 1190
SYSTEM CAPACITY (TONS): 655.7
INSTALLATION DATE (MM/DD/YY): 5/15/92
```

Figure 17. Sample run—new chiller description.

```
**** REFRIGERANT SERVICE****

--- REFRIGERANT RECOVERY ---

REFRIGERANT TYPE: R-11
AMOUNT OF CHARGE (LBS.): 3600
CONDITION OF REFRIGERANT: RECOVERED ONLY

=== REFRIGERANT DESTINATION ===
--- SOLD ---
TOTAL AMOUNT: 3600
DATE: 5/15/92
NAME: XYZ
```

Figure 18. Sample run—old chiller refrigerant recovery.

15. Choose INPUT A REFRIGERANT SERVICE TRANSACTION again from the Main Menu for the case of Refrigerant Addition to the new chiller after its first year of service. Input the information as requested by the menu to record this service transaction. The installation and building number will be the same. Type in "5/15/93" for the service date, then press Enter and Esc. Select the chiller ID number "5XC0103300" in the next screen and press Enter. Select Refrigerant Addition for the desired operation and press Enter.
16. Select "Y" for "Yes" to verify that the chiller is being charged with the same type of refrigerant as that which the chiller runs on; press Enter.
17. For the next three screens, enter "150" lb for the amount of charge added, and press Enter and Esc; select "virgin" as the condition of the refrigerant being added, and press Enter; and select "Local Supply" as the refrigerant source, and press Enter.
18. In the next screen, enter information on the refrigerant obtained from the local supplier. Enter "200" lb as the total amount obtained from the supplier and press Enter. Note that this amount exceeds the amount added to the chiller. Type in "XYZ" as the name of the supplier (contractor) and press Enter. Enter "5/15/93" as the date when the refrigerant was obtained. Press Enter and Esc.
19. Since the amount obtained from the local supplier exceeds the amount that was added to the chiller, the next screen asks where the unused amount (50 lb) obtained from the supplier was stored. Select "In-house stockpile" to indicate that the unused portion of refrigerant was stored on the installation in its stockpile warehouse; press Enter.
20. Note that the total unused amount automatically appears on this next screen and cannot be altered. Input the warehouse building number and date, "WH1" and "5/15/93," respectively, then press Enter and then Esc. This completes the Refrigerant Addition transaction for this new chiller.
21. When finished, the user can view the input information (Figure 19).
22. Select "YES" to print the output screens. Select "YES" to save this refrigerant service transaction. Press Return for the Main Menu.
23. The program can be terminated from the Main Menu by selecting EXIT.

## \*\*\*\* REFRIGERANT SERVICE\*\*\*\*

## ---- REFRIGERANT ADDITION ----

REFRIGERANT TYPE: R-134a  
AMOUNT OF CHARGE (LBS.): 150  
CONDITION OF REFRIGERANT: VIRGIN  
REFRIGERANT SOURCE: LOCAL SUPPLY  
SUPPLIED AMOUNT: 200  
SUPPLIED DATE: 5/15/93  
NAME OF SUPPLIER: XYZ

--- UNUSED REFRIGERANT IN IN-HOUSE STOCKPILE ---  
STOCKPILE BUILDING NUMBER: WH1  
AMOUNT: 50  
DATE: 5/15/93

Figure 19. Sample run—new chiller refrigerant addition.

### Discussion of Level 1 Sample Output

Each chiller is described in the CHILLER DESCRIPTION screens (Figures 16 and 17). Figure 16 shows that the old chiller was approximately 22 years old (installed in 1970) when it was replaced in 1992 (refrigerant service date) with a new, smaller capacity chiller (Figure 17). The old unit ran on a CFC refrigerant, R-11; the new unit uses R-134a, a non-CFC based refrigerant.

The REFRIGERANT SERVICE screens (Figures 18 and 19) present information on the refrigerant transactions performed on the old and new chillers. In the Refrigerant Recovery transaction on the old chiller (Figure 18), the total R-11 refrigerant charge (3600 lb) was recovered from the unit on 12 May 1992 (refrigerant service date) and stored in a container without any further treatment; hence, the condition of the refrigerant was "Recovered Only." It was later sold to a local supplier, XYZ, on 15 May 1992.

In the Refrigerant Addition transaction on the new chiller (Figure 19), refrigerant needed to be added to the chiller after it had run for 1 year (refrigerant service date May 15, 1993). The new chiller was charged with virgin R-134a refrigerant from the same local supplier. The "Refrigerant Source" indicates the local supplier. The name of the supplier (XYZ), the amount of the R-134a refrigerant provided in pounds by the supplier (200), and the date this amount was provided by the supplier (5/15/93) are all provided in this refrigerant addition transaction. Note that the amount of virgin R-134a obtained from the supplier was 200 lb, whereas the chiller was charged with only 150 lb of this refrigerant. The remaining 50 lb was stored in the in-house stockpile warehouse number WH1 on 15 May 1993.

## 5 Summary

In this study, the *Refrigerant Management System (RMS)*, was developed. RMS is a refrigerant management system that aides air conditioning and refrigeration operators in tracking refrigerant services (additions and recoveries) performed on air-conditioning and refrigeration systems. *RMS* consists of two modules, reflecting the steps of the RMS information process: data collection and report generation. Level 1 is a menu-driven computer program that provides for a continuous logging of refrigerant service transactions for each piece of AC/R equipment on an Army installation. Level 2 provides summaries of equipment and refrigerant totals to aid in the preparation of reports and installation refrigerant usage evaluations.

*RMS* helps to determine the refrigerant consumption of an installation, and to prioritize maintenance repairs, conversions, and replacements of AC/R equipment. By providing a refrigerant inventory data base of AC/R equipment and tracking subsequent refrigerant services performed on those pieces of equipment, *RMS* fills the need for refrigerant inventory control, reporting, and management as required by law and military regulations.

## References

Army Letter [LTR] 200-90-1, *Eliminating or Minimizing Atmospheric Emissions of Ozone Depleting Substances* (Headquarters, Department of the Army [HQDA], Washington, DC, 27 July 1990).

Federal Register (FR), vol 58, p 15017.

Federal Register (FR), vol 58, p 28701.

Federal Register (FR), vol 58, p 65018.

International Legal Materials, vol 26, p 1541 (1987), *United Nations: Protocol on Substances That Deplete The Ozone Layer* (Montreal, Canada, 16 September 1987).

International Legal Materials, vol 32, p 874 (1993), *United Nations: Montreal Protocol on Substances That Deplete the Ozone Layer—Adjustments and Amendment* (Adopted at Copenhagen, Denmark, 23-25 November 1992).

Military Directive 6050.9, *Chlorofluorocarbons (CFCs) and Halons* (Department of Defense [DOD], 13 February 1989).

Public Law (PL) 101-549, Title VI – *Stratospheric Ozone Protection* (15 November 1990).

## Appendix A: Definitions of Refrigerant Conditions

*Dispose*—To sell used refrigerant (typically burnout refrigerant) to a supplier. The supplier returns the used refrigerant to the manufacture, who then incinerates the refrigerant if it is not reclaimable.

*Reclaim*—To purify a used refrigerant to new product specifications using a distillation method. Such treatment is usually done at an off-site facility or laboratory, however, “reclaiming” equipment is beginning to appear on the market.

*Recover only*—To simply remove refrigerant from a system and store it in a container without treating or processing the refrigerant in any way. Recover-only equipment is used to perform this task.

*Recycle*—To remove refrigerant from a system, separate the oil from the refrigerant and reduce the moisture, acidity, and noncondensibles in the refrigerant using recover and recycle equipment. The recycled refrigerant is stored in a labeled container until further use.

*Virgin*—Pure, unused refrigerant.

## **Appendix B: Program Flow Charts**





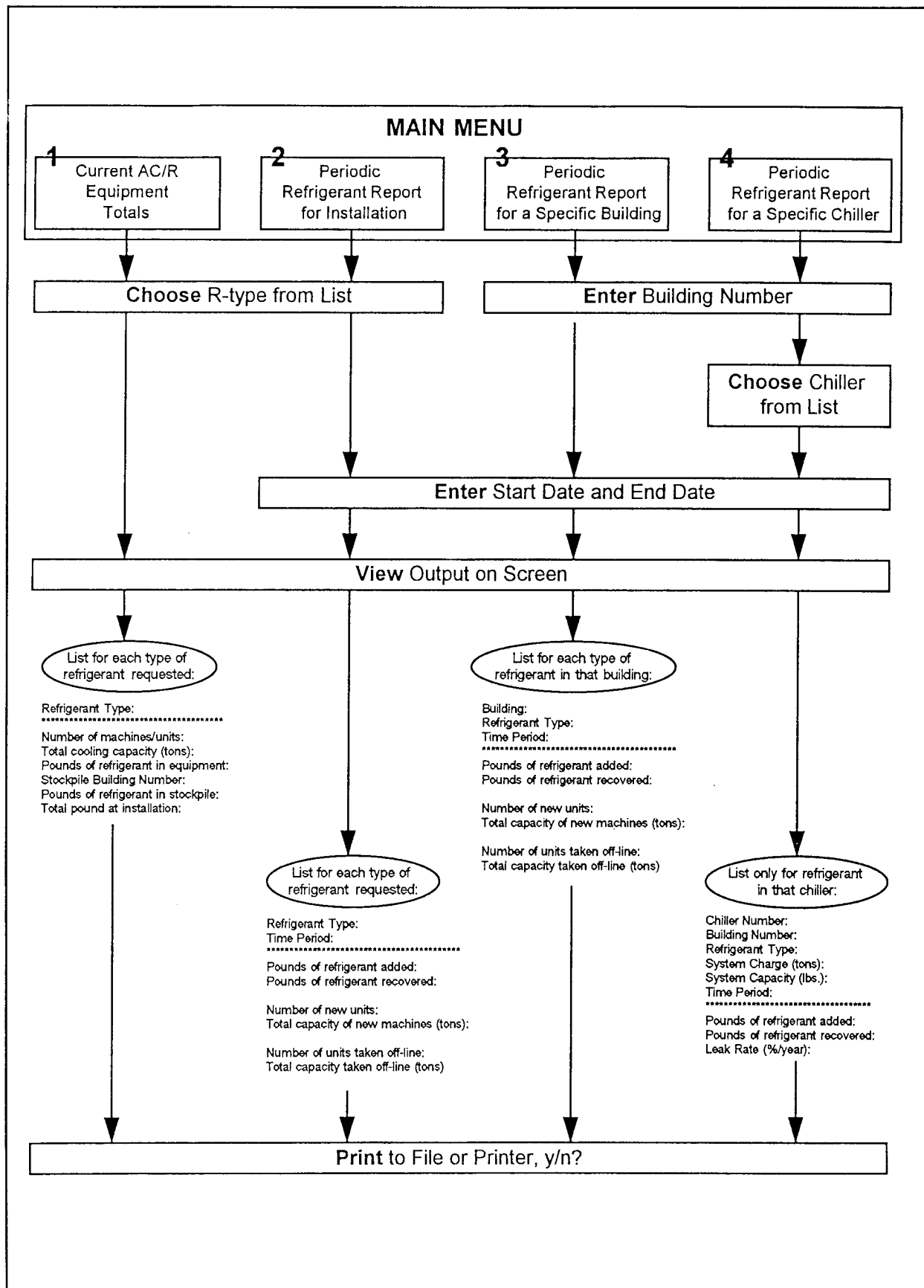


Figure B2. Level 2 program flow chart.

## USACERL DISTRIBUTION

## Chief of Engineers

ATTN: CEHEC-IM-LH (2)  
 ATTN: CEHEC-IM-LP (2)  
 ATTN: CECG  
 ATTN: CECG-P  
 ATTN: CECG-R  
 ATTN: CECW  
 ATTN: CECW-O  
 ATTN: CECW-P  
 ATTN: CECW-PR  
 ATTN: CEMP  
 ATTN: CEMP-E  
 ATTN: CEMP-C  
 ATTN: CEMP-M  
 ATTN: CEMP-R  
 ATTN: CERD-C  
 ATTN: CERD-ZA  
 ATTN: CERD-L  
 ATTN: CERD-M  
 ATTN: CERM  
 ATTN: DAEN-ZC  
 ATTN: DAIM-FDP

CECPW 22310-3862  
 ATTN: CECPW-E  
 ATTN: CECPW-FT  
 ATTN: CECPW-ZC

US Army Engr District  
 ATTN: Library (40)

US Army Engr Division  
 ATTN: Library (12)

## US Army Europe

ATTN: AEAEN-EH 09014  
 ATTN: AEAEN-ODCS 09014  
 29th Area Support Group  
 ATTN: AEUSG-K-E 09054  
 100th Area Support Group  
 ATTN: AETT-SG-DPW 09114  
 222d BSB Unit #23746  
 ATTN: AETV-BHR-E 09034  
 235th BSB Unit #28614  
 ATTN: AETV-WG-AM 09177  
 293d BSB Unit #29901  
 ATTN: AEUSG-MA-E 09086  
 409th Support Battalion (Base)  
 ATTN: AETTG-DPW 09114  
 412th Base Support Battalion 09630  
 ATTN: Unit 31401  
 CMTIC Hohenfels 09173  
 ATTN: AETTH-SB-DPW  
 Mainz Germany 09185  
 ATTN: AETV-MNZ-E  
 21st Support Command  
 ATTN: DPW (9)  
 US Army Berlin  
 ATTN: AEBA-EH 09235  
 SETAF  
 ATTN: AESE-EN-D 09613  
 ATTN: AESE-EN 09630  
 Supreme Allied Command  
 ATTN: ACSGEB 09703  
 ATTN: SHIHB/ENGR 09705

## INSCOM

ATTN: IALOG-I 22060  
 ATTN: IAV-DPW 22186

USA TACOM 48397-5000  
 ATTN: AMSTA-XE

Defense Distribution Region East  
 ATTN: DDRE-WI 17070

HQ XVIII Airborne Corps 28307  
 ATTN: AFZA-DPW-EE

4th Infantry Div (MECH) 80913-5000

ATTN: AFZC-FE

US Army Materiel Command (AMC)  
 Alexandria, VA 22333-0001  
 ATTN: AMCEN-F  
 Installations: (20)

## FORSCOM

Forts Gillem & McPherson 30330  
 ATTN: FCEN  
 Installations: (22)

## 6th Infantry Division (Light)

ATTN: APVR-DE 99505  
 ATTN: APVR-WF-DE 99703

## TRADOC

Fort Monroe 23651  
 ATTN: ATBO-G  
 Installations: (20)

## Fort Belvoir 22060

ATTN: CETEC-IM-T  
 ATTN: CETEC-ES 22315-3803  
 ATTN: Water Resources Support Ctr

## USA Natick RD&amp;E Center 01760

ATTN: STRNC-DT  
 ATTN: DRDNA-F

US Army Materials Tech Lab  
 ATTN: SLCMT-DPW 02172

## USARPAC 96858

ATTN: DPW  
 ATTN: APEN-A

## SHAPE 09705

ATTN: Infrastructure Branch LANDA

Area Engineer, AEDC-Area Office  
 Arnold Air Force Station, TN 37389

## HQ USEUCOM 09128

ATTN: ECJ4-LIE

## AMMRC 02172

ATTN: DRXMR-AF  
 ATTN: DRXMR-WE

## CEWES 39180

ATTN: Library

## CECRL 03755

ATTN: Library

## USA AMCOM

ATTN: Facilities Engr 21719  
 ATTN: AMSMC-EH 61299  
 ATTN: Facilities Engr (3) 85613

## USAAARMC 40121

ATTN: ATZIC-EHA

## Military Traffic Mgmt Command

ATTN: MTEA-GB-EHP 07002  
 ATTN: MT-LOF 20315  
 ATTN: MTE-SU-FE 28461  
 ATTN: MTW-E 94626

## Fort Leonard Wood 65473

ATTN: ATSE-DAC-LB (3)  
 ATTN: ATZT  
 ATTN: ATSE-CFLO  
 ATTN: ATSE-DAC-FL  
 ATTN: Australian Liaison Office

## Military Dist of WASH

Fort McNair  
 ATTN: ANEN 20319

USA Engr Activity, Capital Area  
 ATTN: Library 22211

US Army ARDEC 07806-5000  
 ATTN: AMSTA-AR-IMC

Engr Societies Library  
 ATTN: Acquisitions 10017

Defense Nuclear Agency  
 ATTN: NADS 20305

Defense Logistics Agency  
 ATTN: DLA-WI 22304

Walter Reed Army Medical Ctr 20307

National Guard Bureau 20310  
 ATTN: NGB-ARI

US Military Academy 10996  
 ATTN: MAEN-A  
 ATTN: Facilities Engineer  
 ATTN: Geography & Envr Engrg

Naval Facilities Engr Command  
 ATTN: Facilities Engr Command (8)  
 ATTN: Division Offices (11)  
 ATTN: Public Works Center (8)  
 ATTN: Naval Constr Battalion Ctr 93043  
 ATTN: Naval Facilities Engr Service Center 93043-4328

8th US Army Korea  
 ATTN: DPW (12)

USA Japan (USARJ)  
 ATTN: APAJ-EN-ES 96343  
 ATTN: HONSHU 96343  
 ATTN: DPW-Okinawa 96376

416th Engineer Command 60623  
 ATTN: Gibson USAR Ctr

## US Army HSC

Fort Sam Houston 78234  
 ATTN: HSLO-F  
 Fitzsimons Army Medical Ctr  
 ATTN: HSHG-DPW 80045

## Tyndall AFB 32403

ATTN: HQAFCEA Program Ofc  
 ATTN: Engrg & Svc Lab

## USA TSARCOM 63120

ATTN: STSAS-F

American Public Works Assoc. 64104-1806

US Army CHPPM  
 ATTN: MCHB-DE 21010

US Gov't Printing Office 20401  
 ATTN: Rec Sec/Deposit Sec (2)

Natl Institute of Standards & Tech  
 ATTN: Library 20899

National Training Center  
 ATTN: AFJ-EHE-PM 92310

OASA/IL&E  
 Washington, DC 20310

Defense Tech Info Center 22304  
 ATTN: DTIC-FAB (2)